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13. ABSTRACT *(Maximum 200 words)*

The calculations for considering linear sound-speed profiles in channels have been generalized to treat piece-wise linear sound-speed profiles. Calculation of the scattering coefficients for the linear profile was begun. The case of a channel with a complex bottom impedance condition was also under investigation. As a result of the fact that the eigenvalues are now complex, a diffusion-like term has been added to the governing coherence equations. We began studies of methods to calculate the effect of this term since the governing equations can no longer be reduced to a set of ordinary differential equations for cylindrically symmetric sources. The work on the two- frequency coherence equations continued and the conditions for their validity were carefully considered. It was shown that for large normalized frequency differences the governing equations simplified considerably. We also began looking for a suitable asymptotic formulation to determine the effect of the small normalized frequency differences for very long propagation distances.

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The following topics were studied during the report period:

1) Combined volume and surface scattering in a channel, using a modal formulation.

2) Spatial spectral analysis of scattering in a random media. Single-frequency and two-frequency formulations.

3) Data analysis to determine vertical and horizontal correlation lengths of the random index-of-refraction fluctuations in a channel.

4) The effect of random fluctuations on the two-frequency coherence function in a shallow channel.

5) Approximate eigenfunctions and eigenvalues for linear sound-speed profiles and a bottom impedance condition. Generalized coherence equation for complex bottom impedance condition.

Topics 1-5 were reported upon in the previous progress reports (Jan. 1, 1994 - Oct. 31, 1994, Nov 1, 1994 - Dec. 31, 1994, Jan. 1, 1995 - June 30, 1995). The progress we have made since these reports is updated in this report. ONR has granted a no-cost extension of the grant until August 31, 1996.

1. Combined volume and surface scattering in a channel using a modal formulation.

A paper on this subject is currently under review. During the review process we have clarified the conditions under which the selection rules are applicable to the formulation. The final results of the paper are unaffected.

2. Spatial spectral analysis of scattering in a random media. Single-frequency and two-frequency formulations.

In preparation for a spatial spectral analysis of the transverse direction in shallow water channel propagation a spectral spatial analysis was developed for an infinite medium. (This work was performed in conjunction with an investigator not supported by ONR). This work generalized previous work on propagation through random media by considering wide angle scattering. Basic difference equations were derived and it was shown under what conditions the difference equations could be approximated by differential equations. The formulation was extended to the two-frequency case and some analysis was done on pulse propagation using the two-frequency results.

3. Data analysis to determine vertical and horizontal correlation lengths of the random index-of-refraction fluctuations in a channel.

No further work was done on the detailed analysis of the horizontal correlation.

4. The effect of random fluctuations on the two-frequency coherence function in a shallow channel.

The two-frequency formulation has been completed and numerical calculations for the two-dimensional problem have begun. Since the self-coherence function is now complex the calculations are somewhat more cumbersome. The basic governing equation for large frequency differences is different from the equation for small frequency differences and we are studying how the equations overlap in the transition region.

(The doctoral student working on this problem is not supported by ONR).

5. Approximate eigenfunctions and eigenvalues for linear sound-speed profiles and a bottom impedance condition. Generalized coherence equation for complex bottom impedance condition.

As we stated in the last report, T. Barnard, the Ph.D. student, has written up his analysis for determining the eigenfunctions and eigenvalues for the linear profile and generalized his approach to include piecewise linear profiles. During this report period he has developed a more efficient procedure for determining the eigenvalues of the bottom impedance condition. He is also calculating the eigenfunctions and studying their behavior as a function of channel depth. He is using the eigenfunctions to calculate the scattering coefficients. The results will be compared to the rigid bottom case.

For the complex bottom impedance condition the coherence equation must be generalized to include a diffusion-type term. In the three-dimensional calculation this term precludes the reduction of the problem to the solution of a coupled set of ordinary differential equations for the self modes. The numerical calculations will thus be done first for the two-dimensional case. The possibility of using a perturbation procedure for the three-dimensional problem is being considered.

During the period Jan. 1, 1995 - August 31, 1995 only Mr. Barnard will be supported by the grant. However, the principal investigator will continue to supervise his work.